

## CLAIMS

What is claimed is:

1. A method for estimating the topological dimension of a set of data points  
5 representing a nonlinear system response, each data point having the same  
number of coordinates, the method comprising the steps of:  
identifying a maximal set of non-redundant, nonlinear single-constraint  
fits to data points which are in the neighborhood of a predetermined base point,  
in which the gradient of each fit in the neighborhood of the base point identifies  
10 a constrained direction;  
estimating the number of constraints in the neighborhood of the base  
point to be the same as the number of such constrained directions that are  
linearly independent;  
estimating the topological dimension of the set of data points to be the  
15 original number of coordinates of the data minus the estimated number of  
constraints;  
wherein the step of identifying a set of fits further comprises the step of:  
using a matrix decomposition technique to find singular values and  
singular vectors, or eigenvalues and eigenvectors, of a design matrix  
20 formed from basis functions constructed from the data values; and  
wherein each fit is a linear combination of a set of basis functions for  
which the zero-contours of the fit, that is, the curves at which the fit has the  
value zero, pass near the data points and a set of individual coefficients  
multiplying the individual basis functions, wherein the coefficients of the basis  
25 functions are the components of singular vectors obtained from a decomposition  
of the design matrix.

2. A method as in claim 1 wherein the step of identifying the number of constraints further comprises the step of:  
attenuating fits that have near-zero gradients at the base point.
- 5 3. A method as in claim 1 wherein the matrix decomposition technique is a singular value decomposition of the matrix.
4. A method as in claim 1 wherein the matrix decomposition technique is an eigenvector decomposition of the matrix product of the transpose of the matrix  
10 and the matrix itself.
5. A method as in claim 1 wherein the step of estimating the number of constraints additionally comprises the step of:  
weighting the gradients by a weighting factor which depends upon an  
15 uncertainty level in the data points, to effectively retain only statistically significant gradient terms.
6. A method as in claim 1 wherein the step of estimating the number of constraints additionally comprises the step of:  
20 weighting the gradients by a weighting factor which depends both upon an uncertainty level in the data points and the number of independent basis functions, to effectively retain only statistically significant gradient terms.
7. A method as in claim 1 wherein the estimated number of constraints is reduced  
25 by excluding directions that are assumed to be unconstrained.
8. A method as in claim 10 wherein data points near or at the base point may be filtered or projected in such a way as to satisfy the constraints.

9. A method for estimating the topological dimension of a set of data points representing a nonlinear system response, each data point having the same number of coordinates, the method comprising the steps of:
- 5 identifying a maximal set of non-redundant, nonlinear single-constraint fits to data points which are in the neighborhood of a predetermined base point, in which the gradient of each fit in the neighborhood of the base point identifies a constrained direction;
- estimating the number of constraints in the neighborhood of the base point
- 10 to be the same as the number of such constrained directions that are linearly independent;
- estimating the topological dimension of the set of data points to be the original number of coordinates of the data minus the estimated number of constraints
- 15 wherein each direction that is assumed to be unconstrained may be weighted by a factor which reflects a confidence level in the assumption.
10. A method as in claim 9 wherein the step of identifying the number of constraints further comprises the step of:
- 20 attenuating fits that have near-zero gradients at the base point.
11. A method as in claim 9 additionally comprising the step of:
- identifying constraints that could have arisen for noisy data points if true underlying values of the data points had been mis-measured slightly by an
- 25 amount consistent with an assumed level of noise in the data.

12. A method as in claim 9 wherein the step of estimating the number of constraints additionally comprises the step of:  
weighting the gradients by a weighting factor which depends upon an uncertainty level in the data points, to effectively retain only statistically significant gradient terms.
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13. A method as in claim 9 wherein the step of estimating the number of constraints additionally comprises the step of:  
weighting the gradients by a weighting factor which depends upon the number of independent basis functions allowed for the fits.
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14. A method as in claim 9 wherein the step of estimating the number of constraints additionally comprises the step of:  
weighting the gradients by a weighting factor which depends both upon an uncertainty level in the data points and the number of independent basis functions, to effectively retain only statistically significant gradient terms.
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15. A method as in claim 9 wherein the estimated number of constraints is reduced by excluding directions that are assumed to be unconstrained.
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16. A method as in claim 9 wherein the assumed level of noise may be different for each data point.
17. A method as in claim 9 wherein data points near or at the base point may be filtered or projected in such a way as to satisfy the constraints.
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